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Renewable Energy: a Development Opportunity for Rural Regions in Poland

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Abstract

The article presents the current situation in selected types of renewable energy and their importance for rural areas. At the moment, Poland's energy needs are more than 85% satisfied from fossil fuel resources such as coal, oil, and natural gas. This results in serious environmental impacts and contributes to irreversible adverse effects, such as climate change due to the rise in global temperatures, greenhouse gas emissions, and air pollution. Directives and agreements of the European Union pertaining to climate change force the development in the field of renewable energy sources (RES). In this scope, the production of electricity and heat from renewable sources in rural areas creates new opportunities for the development of these areas and their local communities.

Keywords: renewable energy, rural areas, biomass

Introduction

New transformation processes have been observed in rural areas over the recent years. Increasingly, these processes involve non-agricultural functions, which are becoming more and more important for the community. The changes result from many interacting economic, social, and political processes, and can be associated with environmental issues as well as with the way of rural development. Another important issue is the place of the rural area within the local, regional, and national space. This is to some degree related with the pattern of changes that results from the availability of rural areas and their centrality or peripherality.

1 The importance of rural areas

Central Statistical Office of Poland defines rural areas as territories located outside the administrative boundaries of the cities. They also include towns with up to 5 000 residents and towns with 5 000–20 000 inhabitants which lack schools offering secondary-level education (baccalaureate, Polish: *matura*).[1] Poland's rural areas, which definitely dominate today's landscape, occupy more than 93,2% of the total area of Poland and are inhabited by 14,8 million people, which represent 38,8% of the total population. The rural areas in Poland consist of 54,0% arable land and 28,6% forest (Nurzyńska and Drygas 2011, 188).[2]

What is characteristic is that rural areas are poorly set up with basic technical infrastructure, as compared with urban areas; however, spending for this purpose has been considerable in recent years. This was possible thanks to a number of financial programs launched after Polish accession to the European Union. Many of the programs are shaped to help the rural areas invest in

1. Source: the website of the Central Statistical Office (GUS), [@:] http://www.stat.gov.pl (accessed 2014.06.27).

2. [In the journal European practice of number notation is followed—for example, 36 333,33 (European style) = 36 333.33 (Canadian style) = 36,333.33 (US and British style).—Ed.]

technical infrastructure. Examples include the previous PHARE and SAPARD and today's Structural Funds under the Rural Development Programme (RDP) for 2007–2013 and 2014–2020. From this scope the action "Basic services for the rural economy and community" stands out, providing funding of up to 75% of eligible costs of projects in the following fields:

- water and wastewater management, in particular water supply and wastewater disposal and treatment, including network sewage systems or farm sewage treatment facilities
- creation of a system of collection, segregation and disposal of municipal waste
- production or distribution of energy produced from renewable sources, particularly wind, hydro, geothermal, solar, biogas, or biomass

The following sections describe the issues related to the general situation in the sector of bio-energy and the possibility of using agriculture-produced biomass for the production of biogas.

2 Selected renewable energy sources and rural development

Renewable energy is defined as the energy produced through natural recurring processes and derived from non-fossil resources (such as hydropower, wind power, solar radiation, geothermal heat, sea waves and tides, as well as the energy coming from combustion of biogas and biomass). The renewable energy sources (RES) represent an alternative for conventional, non-renewable fossil fuels. Renewable resources are replenished in natural processes, which practically means that they can be treated as inexhaustible. What is more is that energy produced from renewable sources is more environment-friendly, as compared with fossil fuels. The use of renewable energy significantly reduces the harmful impact of existing power plants on the environment, mainly by reducing noxious emissions, especially of greenhouse gases. Renewable energy represented 11,2% of the total primary energy production in Poland in 2012. The largest proportion in this was energy from solid biomass (85,57%) (see: Berent-Kowalska et al. 2013)

According to the terminology of the Central Statistical Office, biomass is a "biodegradable fraction of products, waste and residues of biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste."[3] The Directive 2001/77/EC4 states that biomass is defined as the biodegradable fraction of products, waste and residues from agriculture, forestry and related industries, as well as industrial and municipal waste that is used as substrate to produce solid, liquid, and gaseous fuels. It should be stressed that biomass is the major carrier of primary renewable energy[5] (figure 1).

As a result of conversion (combustion, fermentation, gasification, or esterification), biomass represents an important source of primary energy for such industries as electricity production, grid

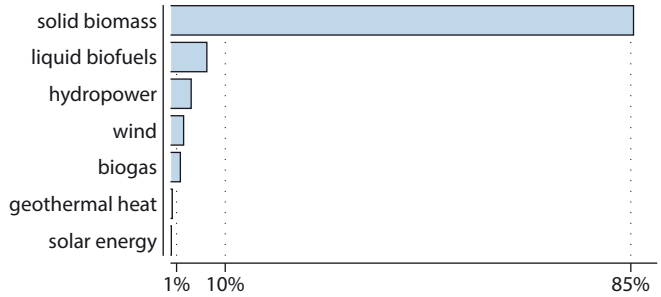

Fig. 1. Renewable energy sources in Poland in 2012 (own graph, data courtesy of the Institute for Renewable Energy, EC BREC IEO, Ltd, Warsaw)

3. See "biomass" definition at http://stat.gov.pl/en/metainformations/glossary/terms-used-in-official-statistics/2823,term.html.

4. See: Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market, OJ L 283, 27.10.2001, p. 33–40.

5. Central Statistical Office defines primary energy as the sum of energy embodied in the primary energy commodities that come from natural, both renewable and non-renewable resources; see "primary energy" definition at http://stat.gov.pl/en/metainformations/glossary/terms-used-in-official-statistics/93,term.html.

heating, refrigerated storage, or transportation. Selection of the conversion method depends on the type of energy we want to obtain (electrical power, heat of liquid fuel) and on the primary form of the substrate. There are three forms of biomass:

- solid — agriculture biomass (straw, energy crops), waste biomass (organic municipal and industrial waste), and forestry biomass (wood and wood processing waste);
- liquid — mainly agriculture biomass (plant oil, animal fat) processed for biofuel components (biodiesel, bioethanol);
- gaseous — biogas obtained through anaerobic digestion of organic compounds, wastewater treatment plant gas, produced from organic waste on landfills or from agriculture biomass (in agriculture biogas plants).

Due to the existence and magnitude of agricultural production in Poland, agricultural biomass is the most important and the most promising source of renewable energy. The resources of biomass for energy purposes in Poland, estimated differently in a variety of reports and strategic documents, are greatest among all other Poland's renewable energy sources. Also, it is the chief energy source used in all energy sectors:

- electricity production — approx. 60% of renewable energy produced in this sector is obtained from biomass; the largest proportion of energy from biomass is generated by co-incineration of biomass in high-power coal-fired condenser boilers;
- heating and refrigerated storage — about 95% of consumed renewable energy comes from biomass; thermal energy is generated mainly by scattered, small and medium power units not connected to the district heating network;
- transportation — approx. 100% renewable energy comes from biomass; these are first-generation biofuels, including bioethanol and biodiesel.

With the developments in RES, new technologies are being proposed to exploit the energy potential in biomass. In contrast to such energy sources as wind and hydropower, which allow generation of electricity from kinetic and potential energy, biomass gives us many more options.

The dominant technology in Poland in terms of renewable energy is straw pelleting and briquetting.[6] Such product is then combusted in special boilers and converted into heat or electricity. Biomass can also be gasified; this technology is used primarily in agricultural biogas plants that produce gas from energy materials that are in fact by-products of agriculture. These materials can also be processed into liquid biofuels, such as biodiesel or bioethanol. Biomass is also found in the municipal waste dumps and in solid wastes from sewage treatment plants, from which biogas is produced.

Food production has been so far the major objective of the agricultural sectors of economy. The resolution by the European Parliament "The Common Agricultural Policy towards 2020," adopted on 23 June 2011, states that besides food production, the policy of rural development should concentrate on energy self-sufficiency of homesteads and should promote using agricultural by-products for renewable energy production. Hence, not only is renewable energy production a choice resulting from peoples' care for the environment, but it is also an obligation imposed by the European Union reflected in the form of various legal documents, international agreements, and directives. On this basis, in order to fulfill the undertaken commitments, actions should be taken to utilize RES in various sectors of the national economy. This also pertains to agriculture. A farm may become a producer of energy materials based on its by-products, being the energy producer and a consumer.

Biomass is potentially the largest source of energy in the world and in Poland. It is a natural material which contains the solar energy deposited in the biomass during its formation. As it has already been mentioned, agricultural biomass and, particularly, the straw of crop plants is of highest importance. The most important characteristic of this material is its lower SO_2 and CO emission compared do fossil fuels (such as hard coal and lignite). In addition, the balance of CO_2 resulting from the combustion of biomass is equal to zero due to its re-absorption in the

6. Pellet — heating material made from compressed recycled wood waste: sawdust, wood shavings, wood chips (also bark, straw, and energy crops are used). Produced in the form of spherical or cylindrical granules with a diameter of 6–25 mm and a length of up to a few centimeters.

process of photosynthesis, in which the fuel is renewed (Grzybek, Gradziuk, and Kowalczyk 2001, 15). Besides ecological aspects, overproduction of food and increased unemployment in the rural areas advocate the use of biomass for energy production. Basing on reports by many authors, one may suppose that two metric tons of straw or wood are equivalent — in terms of energetic value — to one ton of good quality coal. If we consider cereal crops grown on 1 ha of arable land (AL), this allows harvesting of 10 to 12 tons of straw, which is equivalent to 5–8 tons of coal. The studies by Grzybek et al. demonstrate that in Poland there is an annual production surplus of more than 11 million tons of straw which still can be utilized. Most of this surplus is produced in Wielkopolskie, Pomorskie, Zachodniopomorskie, Kujawsko-Pomorskie, Mazowieckie, Lubelskie, and Warmińsko-Mazurskie voivodships. This results from large areas of farms and a large scale of crop production in these voivodships.

Renewable energy production always has an impact on the environment. Straw is no exception. Its combustion results in emission of various compounds, such as SO_2, NO_x, CO_2, CO, and particulates. The magnitude of these emissions is, however, much lower if compared to coal or petrol combustion. It is important to notice that straw is a biofuel that is fully renewable, and its full cycle of transformation is one year. More specifically, this means that the amount of CO_2 emitted into the atmosphere during the combustion of a given quantity of straw in a given year is absorbed during the growing season in the process of photosynthesis within the following year. Previous studies also reveal that the quantity of CO_2 emitted during combustion is identical to that produced from the natural decomposition of straw. In conclusion, the use of straw for energy production is neutral in terms of carbon dioxide balance.

Biogas producing plants are another example of the possibilities for the production of renewable energy in rural areas. Using methane fermentation carried out under controlled conditions, biogas[7] is produced to be ultimately converted to electrical or thermal energy. Until the amendment of the Energy Law in 2011, the very general term "biogas" was defined as a gas obtained from agricultural biomass, waste of sewage treatment plants and waste recovered from dumps (landfills). Electricity production from biogas in Poland is so far a small percentage of the total energy production. According to CSO data, the share of biogas in the total renewable energy production in 2011 was about 1,8%.

In Poland, the potential energy crop area is about 10,7 million ha, but biogas plants emerge very slowly. For comparison, such an area in Germany reaches 12 million ha, however, more than 7,9 thousand biogas plants are already operational. Germany is that largest biogas producer in the EU. Poland's first biogas producing plant was ready in 2005; there are now more than 200 plants, although only 40 of them are agricultural biogas plants (Kowalczyk-Juśko 2013, 3–8). In Poland, the most common materials for biogas plants are manure and maize silage, which has the highest gas efficiency. From 1 ha of this crop a plant can produce 19 thousand m^3 of biogas. Another advantage of maize is that it is very easy to preserve (by ensiling) and so the material can be used year-round. Growing crops for the biogas plant does not differ significantly from growing crops for other purposes, such as animal feeds. The purpose and effect of crop production is to obtain green forage containing as much dry matter as possible.

In addition, cattle manure and poultry manure may also be used as biogas materials. The greatest potential of biogas production in Poland are for farms specializing in livestock production with a large number of animals (over 100 LU). In the absence of such large farms, there is a possibility for biogas plant ventures by groups of many producers having smaller animal herds. As a result of the full cycle of fermentation, a by-product in the form of pulp is obtained, which is a valuable organic fertilizer to be readily used on the fields. The fertilizer contains a high level of easily absorbable phosphorus and potassium, as well as a preferred form of nitrogen: ammonia nitrogen (lower pollution of surface waters by nitrate nitrogen compounds). Moreover, the fertilizer is a pathogen-free digestate free of weed seeds.

7. Agricultural biogas — a fuel gas produced by the anaerobic digestion of agricultural materials, different forms of by-products, or from forest biomass. This does not include the gas obtained from wastewater treatment plants and municipal waste landfills. See: Ustawa z dnia 19 sierpnia 2011 r. o zmianie ustawy – Prawo energetyczne oraz niektórych innych ustaw, DzU nr 205, poz. 1208.

The costs of creating an operational biogas plant in Poland are not low. Estimates say that unit cost per 1 MW of produced energy costs about PLN 15 million (about EUR 3,6 million). If there is support in the form of EU aid funds, the overall investment may pay off within 5 years; one must not forget, however, the social and environmental benefits of such investments.

Ecological benefits resulting from the agricultural biogas-based electricity and heat production are as follows:

- reduced emission of greenhouse gases, such as nitrogen suboxide, methane, and carbon dioxide
- reduced consumption of fossil fuels and, consequently, reduced emission from combustion of these fuels
- lower risk of groundwater and surface water pollution
- improved fertilizing of arable land, as compared with undigested manure

Limitations with respect to the locality of such investments include landscape parks, *Natura 2000* protected areas, areas of protected landscape, ecological corridors.

Economic benefits of biogas plants are twofold; both the operator of the plant and the local community benefit from it as follows:

- return on sales of energy, heat, digestate, and often fertilizer
- the commune has additional income from taxes paid by the plant operator; indirectly also local markets of fertilizers, pesticides, biomass ensilage additives, and petrol stations benefit from the operation of the biogas plant
- some biogas plants deliver heat to housing areas, schools, public facilities, health centres etc., usually at a lower price
- heat prices are negotiable during the phase of public consultations; long-term agreements are beneficial for both sides.

Social benefits of biogas plant operation are versatile:

- the biogas plant is a new, reliable customer of agriculture products operating on long-term basis agreements
- new employment opportunities are created in growing, harvesting, and processing of the biomass, but also in the biogas plant operation itself
- a new investment means economic revival of the community or region
- communes having biogas-producing facilities are seen as modern and open to new investments and technologies, which creates a positive image
- cooperation and good relations between the local community and the investor often result in new projects for the benefit of the residents, such as building a playground, renovating the community house or the church building

Very common obstacles for the biogas production projects result from conflicts with prejudices of unfriendly local communities. The protests that are often raised against placing a biogas plant in the vicinity are usually an outcome of lacking reliable knowledge on the project or may result from misinformation on the alleged impact of the project on the local community; sometimes these are just mentality barriers. In many cases, the opponents force various authorities to perform frequent inspections of the plant, from which neither party benefit.

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